APPLE CD ROM SCSI COMMAND SET

(Revision 1.4, February 15, 1988.)

The attached document is a fourth draft of the Apple CD ROM SCSI Command Set. It is a complete SCSI command set for the Apple CD ROM product. This command set may or may not be released as section 2.5 of the Apple SCSI Command Protocol specification (062-2075). If this command set is not released as section 2.5 of the Apple SCSI Command Protocol specification, then sections of that specification other than the SCSI command set are also applied to the Apple CD ROM product. Electrical characteristics of the Apple SCSI bus can be found in Apple specification 062-2074.

TABLE OF CONTENTS

			PAGE
Section 2.5		C.D. ROM Commands	2
2.5.1		List of Group 0 Commands for C.D. ROM	3
		Test Unit Ready	4
		Rezero Unit	4
		Request Sense	5
		Read	9
		Seek	9
		Inquiry	10
		Mode Select	12
		Reserve Unit	24
		Release Unit	26
		Mode Sense	27
		Start/Stop Unit	31
		Receive Diagnostic Results	32
		Send Diagnostic	34
		Prevent/Allow Media Removal	36
2.5.2		List of Group 1 Commands For C.D. ROM	37
		Read Capacity	38
		Read Extended	38
		Seek Extended	38
		Verify	39
		Write Buffer	40
		Read Buffer	42
2.5.3		List of Group 6 Commands For C.D. ROM	44
	2.5.3.1	Eject Disc	45
	2.5.3.2	Read TOC	46
	2.5.3.3	Read Q Subcode	49
	2.5.3.4	Read Header	51
	2.5.3.5	Audio Track Search	53
	2.5.3.6	Audio Play	56
	2.5.3.7	Audio Pause	59
	2.5.3.8	Audio Stop	60
	2.5.3.9	Audio Status	63
	2.5.3.10	Audio Scan	66

2.5 C.D. ROM Commands

Disconnect/reselect is required. If the initiator does not respond to the reselection within a Selection Timeout Delay(250ms), the target shall release the bus for 200ms and then try to rearbitrate and reselect again. The target shall try the above disconnect/reselect procedure until the initiator responds or the target receives an abort or bus reset message from the reselecting initiator or a hard reset from the SCSI bus. The target will respond to selection from the same or other initiators between reselection retries.

Disconnect/reselect is also required for audio commands. If the host chooses to use the disconnect/reselect feature, the drive will disconnect only for those operations that involve movement of the optical pickup (i.e. during seek). After the target address is found, the drive will play audio from that target address and reselect the host at the beginning of the audio play or audio scan. Since the reselection process depends on whether the SCSI bus or the host is busy, it is possible that the audio play or audio scan operation begins before the reselection process is completed.

2.5.1 Group 0 Commands for C.D. ROM Devices The Group 0 commands for C.D. ROM devices shall be as shown in Table 2.5.1-1.

Table 2.5.1-1
Group 0 Commands for C.D. ROM Devices

Operation Code	Type	Command Name	Section
00_H	M	TEST UNIT READY	7.1.1
01_H	M	REZERO UNIT	8.1.1
02_H	R		
03_H	M	REQUEST SENSE	7.1.2
04_H	R		
05_H	R		
06_H	R		
07_H	R		
08_H	M	READ	12.1.1
09_H	R		
$0A_H$	R		
$0B_H$	M	SEEK	8.1.6
$0C_H$	R		
$0D_H$	R		
$0E_H$	R		
$0F_H$	R		
10_H	R		
11_H	R		
12_H	M	INQUIRY	7.1.3
13_H	R		
14_H	R		
15_H	M	MODE SELECT	12.1.3
16_H	M	RESERVE UNIT	8.1.8
17_H	M	RELEASE UNIT	8.1.9
18_H	R		
19_H	R		
$1A_H$	M	MODE SENSE	12.1.4
$1B_H$	M	START/STOP UNIT	8.1.11
$1C_H$	M	RECEIVE DIAGNOSTIC RESULTS	7.1.5
$1D_H$	M	SEND DIAGNOSTIC	7.1.6
$1E_H$	M	PREVENT/ALLOW MEDIA REMOVAL	8.1.12
$1F_H$	R		

Key: M = Command implementation is Mandatory.
O = Command implementation is Optional.
R = Command code is reserved for future standardization.

7.1.1 TEST UNIT READY Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 00_H

The TEST UNIT READY command provides a means to determine if the C. D. ROM is powered up and ready for operation, and a disc is mounted. Refer to section 7.1.1 of the ANSI X3T9.2/82-2 Rev. 17B for details.

8.1.1 REZERO UNIT Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 01_H

Table 8-2
REZERO UNIT Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

The REZERO UNIT command (Table 8-2) repositions the drive's optical pickup to the starting address of the disk and enters the HOLD TRACK state for the duration of inactivity time. The drive will spin up if it is not spinning.

If the initiator requests disconnect, disconnect will be performed before the seek operation and reselect will take place following the seek operation.

This command should not change the mode select parameters.

7.1.2 REQUEST SENSE Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 03_H

Extended Sense Data format is Required.

Implementation of the additional sense code (byte 12) is required and the additional sense code of medium change (28H) is mandatory.

The thirteen(13) first bytes of the Extended Format, as defined in the SCSI specifications, are to be supported by the target. All additional bytes are optional.

EXTENDED SENSE DATA

The following bytes are REQUIRED

Bit / Byte	7	6	5	4	3	2	1	0
0	Valid	Error Class=7H			Error Code=0H			
1	Segment Number=00H							
2	FM=0	EOM=0	ILI=0	R	Sense Key			
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte(LSB)							
7	Additional Sense Length (n)							
8	Optional, except for use with SEARCH and COPY (00H)							
through	commands as per 7.1.4.2 (00H)							
11	" " (00H)							
12	Additional Sense Code							

The following bytes are optional and follow the Required Extended Sense Data byte 12.

Bit / Byte	7	6	5	4	3	2	1	0
13	Reserved							
14	FRU failed							
15	FPV	C/D	VU	VU	BPV	Bit Pointer		
16	Field Pointer (MSB)							
17	" " (LSB)							
18- n+17	N/A							

The information bytes are not defined if the **Valid** (address valid) bit is zero. If this bit is one, the information bytes contain the unsigned logical block address associated with the sense key.

The **FM** (File Mark) and the **EOM** (End Of Media) bit are set to zero.

The **ILI** (incorrect length indicator) bit indicates that the requested logical block length did not match the logical block length of the data on the medium. This bit is set to zero.

The **Sense Key** codes of 0H, 1H, 2H, 3H, 4H, 5H, 6H and BH are required. The definition of the **sense key** code is described in Table 7-6 of the ANSI X3T9.2/82-2 Rev. 17B.

The additional sense length specifies the number of additional sense bytes to follow. If the allocation length of the command descriptor block is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

Byte 12 Additional Sense code.
The Additional Sense code 00_H indicates that the target does not support any additional sense code for the related Sense Key or does not have any appropriate additional sense to return for the Check Condition status that it created.

C.D.ROM DEVICES ADDITIONAL SENSE CODES (byte 12)

Code		Related Sense Keys
00	No Additional Sense Information	No Sense
01	Reserved	
02	**Error occurred during seek operation.**	**Hardware error or Medium error**
03	Reserved	
04	Drive Not Ready (i.e. unit off line in multiple LUN system)	Not Ready
05	Reserved	
06	Reserved	
07	Reserved	
08	**Logical Unit Communication Failure**	**Hardware error**
09	**Track servo error**	**Hardware error**
0A through 0F	Reserved	
10	Reserved	
11	L-ECC uncorrectable data error (L-ECC on)	Medium error
12 through 16	Reserved	
17	CIRC recovered data error (L-ECC off)	Recovered error
18	L-ECC recovered data error (L-ECC on)	Recovered error
19	**Reserved**	
1A	Reserved	
1B	Reserved	
1C	Reserved	
1D	Reserved	
1E	**Reserved**	
1F	Reserved	
20	Invalid Command Operation Code	Illegal Request
21	Illegal Logical Block Address	Illegal Request
22	Illegal function for device type	Illegal Request
23	Reserved	
24	Illegal field in CDB other than op-code or illegal logical block address Illegal Request	
25	Invalid logical unit number	Illegal Request
26	Invalid field in Parameter List	Illegal Request
27	Reserved	
28	Medium changed (detected by cartridge insertion)	Unit Attention
29	Power On, Reset or Bus Device Reset occured	Unit Attention
2A	Mode Select Parameters changed	Unit Attention
2B through 2F	Reserved	
30	Reserved	Medium error
31	**Reserved**	
32	Reserved	
33 through 3F	Reserved	
40	SCSI controller data buffer failure	Hardware error
41	**Drive's internal bus data path failure**	**Hardware error**
42	**Power On Diagnostic Failure**	**Hardware error**
43	Message Reject Error (see 5.6.1.5)	**Hardware error or Aborted command**
44	**Internal Controller Error (see 5.6.1.8)**	**Hardware error**
45	Reselect failed (see 5.6.1.7.)	Hardware error

46	Reserved	
	—	
47	**SCSI Interface Parity Error (see 5.6.1.)**	**Hardware error**
48	Initiator Detected Error (see 5.6.1.4)	Hardware error or Aborted command
49	Inappropriate/Illegal Message	Hardware error or Aborted command
4A through 4F	Reserved	
50 through 5F	Reserved	
60 through 6F	Reserved	
70 through 7F	Reserved	
80	Prevent Medium Removal Set	Illegal Request
81	Logical unit is reserved	Illegal Request
82	End of user area encountered on this track(only for data/audio mode change)	Illegal Request
83	Overlapped commands attempted	Absorted Command
84	Illegal mode for this track (e.g. audio command for data track)	Illegal Request
85	Audio address not valid.	Illegal Request
86 through 9F	Vendor Unique	
A0 through A6	Vendor Unique	
A7	Vendor Unique	
A8through AF	Vendor Unique	
B0	No Cartridge in Drive	Not Ready
B1	Unable to recover table of contents(TOC)	Not Ready
B2	Cartridge load/eject failure	Not Ready
B3	CIRC unrecovered data error (L-ECC off)	Medium Error
B4	Focus servo failure	Hardware Error
B5	Spindle servo failure	Hardware Error
B6	Cartridge load mechanism failure	Hardware Error
B7	Read TOC in progress.	Not Ready
B8 through FF	Vendor Unique	

Byte 14 Field Replaceable Unit (FRU) failed. A non zero value indicates failure. A value of zero means that no FRU is to be reported.

Byte 15 definition:
-FPV (Field Pointer Value) Bit 7 of zero indicates that the target does not implement the functions supported by C/D & BPV bits and bytes 16 and 17, therefore these bits and fields are not valid. Bit FPV of one indicates that the Field Pointer bytes 16 and 17, the C/D and BPV bits are significant.
-C/D bit of one indicates that the value reported in the Field Pointer is the CDB's byte number for which an ILLEGAL REQUEST Sense Key was issued. C/D bit of zero indicates that the value reported in the Field Pointer is the byte number of the DATA phase for which an ILLEGAL REQUEST Sense Key was issued.
-Bits 5 and 4 are vendor unique.
-BPV bit of zero indicates that the target does not implement this function, therefore the Bit Pointer field is not valid. BPV bit of one indicates that the Bit Pointer field (bits 0 through 2) is significant.
-Bits 0 through 2, Bit Pointer, indicates which bit of the byte number reported in bytes 16 and 17 is the bit for which the ILLEGAL REQUEST Sense Key was issued.

12.1.1 READ Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 08_H

Refer to section 12.1.1 of the ANSI X3T9.2/82-2 Rev.17B for details. The drive will enter a hold track state at the completion of the read operation for the duration of the inactivity time.

8.1.6 SEEK Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $0B_H$

Table 8-12
SEEK Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

The SEEK command (Table 8-12) requests that the logical unit seek to the specified logical address **and enters the HOLD TRACK state for the duration of the inactivity time.**

7.1.3 INQUIRY Command

Peripheral Device Type:	C.D. ROM
Operation Code Type:	Mandatory
Operation Code:	12_H

Bytes 0 through 53 of the Inquiry data are Required. Bytes 54 through the end of the data are optional.

INQUIRY DATA

Bit	7	6	5	4	3	2	1	0
BYTE 0				Peripheral Device Type (05H)				
BYTE 1	RMB=1			Device Type Qualifier (00H)				
BYTE 2	ISO Version			ECMA Version		ANSI Version=1H		
BYTE 3	Reserved				**Response Data Format=1H**			

Response Data Format:

Code	Description
0_H	Vendor Unique
1_H	**Common Command Set** (CCS)
2_H through F_H	Reserved

Targets conforming to at least conformance level 2 as defined in Table E1, Appendix E, of the standard, and conforming to this document shall set the **Common Command** Set code (1_H) in the Response Data Format field.

BYTE 4	Additional Length (n)
BYTE 5	**Vendor Unique**
BYTE 6 and 7	**Reserved**
BYTE 8 through BYTE 15	**Vendor Identification (in ASCII)** 'Vendor Name'
BYTE 16 through BYTE 31	**Product Identification (in ASCII)** 'CD-ROM'space'Unique model number assigned for Apple'
BYTE 32 through BYTE 35	**Revision Level (in ASCII)** 'Firmware revision level'
BYTE 36 through BYTE 55	**Vendor Unique** (Command Bit Map, see explanation below)
BYTE 56 through BYTE 97	**Reserved**
BYTE 98 through xx	**Vendor Unique**

Beginning at byte 36 in the VENDOR UNIQUE area of the response are extension bytes to specify the number of extents supported by the RESERVE (command $16) and RELEASE (command $17) commands. Following this is a list of SCSI commands supported by this device. Commands map into this list by their group code and command code values. Values are returned by first specifying a Group Code Specifier (a byte for the Group Code value; 0 for Goup 0, 1 for Group 1, etc), then specifying a 4 byte Command Bit Map representing the commands implemented within that group. The bit map is constructed by setting a bit for an implemented command according to that command's value, and clearing a bit otherwise. Bits within the bit map are numbered in ascending order beginning with the first bit following the Group Code Specifier. This list is terminated by specifing a $FF for the Group Code (no additional command bit map bytes are necessary).

Example: The following is an example of the format.

Byte 36:$00	[Hi Order byte - number of Extents]
Byte 37:$00	[Low Order byte -number of Extents]
Byte 38:$00	[Group 0 commands]
Byte 39:$D0	[Commands 0H,1H,3H]
Byte 40:$90	[Commands 8H,BH]
Byte 41:$27	[Commands 12H,15H,16H,17H]
Byte 42:$3E	[Commands 1AH,1BH,1CH,1DH,1EH]
Byte 43:$01	[Group 01 commands]
Byte 44:$04	[Command 25H]
Byte 45:$91	[Commands 28H,2BH,2FH]
Byte 46:$00	[No commands implemented in this range]
Byte 47:$18	[Commands 3BH,3CH]
Byte 48:$06	[Group 6 commands]
Byte 49:$F0	[Commands C0H,C1H,C2H,C3H]
Byte 50:$FC	[Commands C8H to CDH]
Byte 51:$00	[No commands implemented in this range]
Byte 52:$00	[No commands implemented in this range]
Byte 53:$FF	[End of list]

8.1.7 MODE SELECT Command

Peripheral Device Type:	C.D. ROM
Operation Code Type:	Mandatory
Operation Code:	15_H

Table 8-13
MODE SELECT Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				SP=0
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Vendor Unique		Reserved				Flag	Link

Mandatory Page Codes for Mode Select and Mode Sense

1. Page Code $0: Unit Attention
2. Page Code $1: Error Recovery Parameters
3. Page Code $2: Disconnect/Reconnect Control Parameters
4. Page Code $20: Drive Parameters.
5. Page Code $3F: Report Values (Mode Sense only)

The MODE SELECT command (Table 8-13) provides a means for the initiator to specify or change medium, logical unit, target or peripheral device parameters to the target. **This command is Required within the Apple Common Command Set.**

The SP (Save Mode Parameters) bit is set to zero for C.D. ROM.

The Parameter List Length specifies the length in bytes of the MODE SELECT parameter list that shall be transferred during the DATA OUT phase. A parameter list length of zero indicates that no data shall be transferred. This condition shall not be considered an error.

The MODE SELECT parameter list (TABLE 8-14) contains a four-byte header, followed by zero or one block descriptor, **followed by zero or more Pages.**

Table 8-14
Mode Select Parameter List

Mode Select Header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Medium Type=00H							
2	Reserved							
3	Block Descriptor Length (00H or 08H)							

Block Descriptor(s)

Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Number of Blocks (MSB) =00H							
2	Number of Blocks =00H							
3	Number of Blocks (LSB) =00H							
4	Reserved							
5	Block Length (MSB)							
6	Block Length							
7	Block Length (LSB)							

Page Descriptor(s)

Byte	7	6	5	4	3	2	1	0
0	R	R	Page Code					
1	Page Length (in bytes)							
2 to n	Refer to Page definition							

The Medium Type is set to 00H for C.D. ROM.

The Block Descriptor Length specifies the length in bytes of all the block descriptors. A block descriptor length of zero indicates that no block descriptors shall be included in the parameter list. This condition shall not be considered an error. The number of blocks field specifies the number of logical blocks on the medium that meet the block length in the Block Descriptor. **A 00H in all the Number of Blocks fields specifies all the logical blocks of the logical unit.** The Block Length specifies the length in bytes of each logical blocks. Block

Length of 256(100H), 512(200H), 1024(400H), 2048(800H), 2052(804H, optional), 2336(920H) , 2340(924H), or 2352(930H, optional) bytes are supported by the target. The default block length is 2048 bytes.

If the initiator sets the block length to 2336, 2340 or 2352(if implemented) bytes per block and the layered ECC is enabled(i.e. DCR bit is set to zero), the target will generate CHECK CONDITION of illegal request for both mode 1 and mode 2 data block. The initiator should use block length of 2336, 2340 or 2352(if implemented) and layered ECC off to access mode 2 data blocks. Accessing mode 2 blocks by block length other than 2336, 2340 or 2352 (if implemented) will create a CHECK CONDITION.

Optional additional blocks of parameters called *Pages* may be sent to the target in the Data Out phase of the MODE SELECT command, following either:
- the MODE SELECT Header, if the Block Descriptor length is set to zero.
- or one Block Descriptor.

The Block Descriptor Length shall not include the length of the Pages.

Page Definition:
Each defined Page is preceded by a Header of two bytes defining the Page Code and the length of the page. Following the Header, the Pages are separated into sub-blocks containing a list of related flags and/or values.

Bits 7 and 6 of byte 0 are reserved.

The **Page Code** identifies the meaning of the following bytes in the Page. The Page Code is either defined, reserved or vendor unique. The parameters in the defined Pages are classified in priority sequence to ease implementation by the target.

The **Page Length** value of each defined page, shall not include the Page Length byte. The Page Length represents the number of bytes that the target supports in each Page. The target may return in the Pages of the MODE SENSE commands as many consecutive bytes that it supports, for each Page that it supports, without splitting fields of multiple bytes. The Page Length shall be set in the pages of the MODE SELECT commands to the exact same value (zero value included) returned by the target in the MODE SENSE Page Length bytes. Otherwise, the target shall create Check Condition status with the Sense Key of ILLEGAL REQUEST.
The initiator shall issue a MODE SENSE command requesting the target to return all Changeable values (see PCF field configuration 01B in byte 2 of the MODE SENSE CDB) prior to issuing any MODE SELECT commands, in order to find out which Pages are implemented by the target and the length of each Page for that particular LUN(Logical Unit Number).

Initiator Implementor Notes:
- Those Pages, supported by the target, in which the initiator requests parameters to be changed shall be sent to the target.
- The initiator may send in MODE SELECT commands all Pages supported by the target.
- The Pages are not required to be sent in ascending order.

In the event of a *Hard Reset*, the target shall first attempt to restore the Default Parameters.

Page Code	Meaning
0_H –	Unit Attention
1_H	Error Recovery parameters
2_H	Disconnect/Reconnect Control parameters
3_H through $1F_H$	Reserved
20_H	Drive Parameters.
21_H-$2F_H$, 31_H-$3E_H$	Vendor Unique Page formats
$3F_H$	Defined in MODE SENSE only.

The initiator may issue a MODE SELECT command at any time.

The target may or may not save the block descriptors and Pages for each LUN and for each initiator. If the target supports 8 LUNs and the bus configuration includes 7 hosts, the target would have to save 56 sets of MODE SELECT/ MODE SENSE data. The data for each LUN for each host could be different.

If a MODE SELECT command is received from an initiator, the target shall respond to the next command received (except INQUIRY or REQUEST SENSE) from all other initiators with a CHECK CONDITION status. The sense key is set to UNIT ATTENTION and the additional sense code is set to MODE SELECT PARAMETERS CHANGED. The controller will preserve the unit attention condition if an INQUIRY or REQUEST SENSE command is received. The unit attention condition is set upon receipt of the MODE SELECT command by the controller, whether or not any parameters are actually changed.

ERROR RECOVERY PARAMETERS. Page code 1_H.

Bit / Byte	7	6	5	4	3	2	1	0
0	R	R	Page Code=1_H					
1	Page Length (in bytes)							
2	R	R	TB	RC	EEC	PER	DTE	DCR
3	Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Recovery Time Limit = 00H							

NOTE: In the event of a conflict between the bit definitions and the error recovery procedures defined on pages 19 and 20, the error recovery procedures take precedence.

A **DCR (Disable Correction)** bit 0 set to one indicates that the data shall be transferred without applying error correction (layered ECC). A **DCR** bit set to zero enables error correction (layered ECC). **The DCR bit is default to zero**.

A **DTE (Disable Transfer on Error)** bit 1 set to one and if the PER bit is set to one, indicates that the target shall create the Check Condition status and terminate the data transfer to the initiator immediately upon detection of an error. The Transfer Length is then not exhausted. The data of the block in error, which is the first erring block encountered, may or may not be transferred to the initiator depending upon the setting of the TB bit. The DTE bit can only be set to one by the initiator if the PER bit is set to one. The target shall create the Check Condition status with Illegal Request Sense Key, if it receives PER bit of zero and DTE bit set to one.
A **DTE** bit set to zero enables data transfer for any data which can be recovered within the limits of the Error Recovery Flags. Any erring block that would be posted, which is the last recovered block encountered, is not posted until the Transfer Length is exhausted.

The DTE bit is default to zero for C.D. ROM.

A **PER (Post Error)** bit 2 set to one indicates that the target shall enable the reporting of the Check Condition status for recovered errors, with the appropriate Sense Key. The Check Condition shall happen during the data transfer depending either on the DTE bit value or if an unrecoverable error occured. If multiple errors occur, the REQUEST SENSE data shall report the block address of either the last block on which recovered error occured or of the first unrecoverable error.
A **PER** bit set to zero indicates that the target shall not create the Check Condition status for errors recovered within the limits established by the other Error Recovery Flags. Recovery procedures exceeding the limits established by the other Error Recovery Flags shall be posted accordingly by the target. The transfer of data may terminate prior to exhausting the Transfer Length depending on the error and the state of the other Error Recovery Flags.

The PER bit is default to zero.

An **EEC (Enable Early Correction)** bit 3 set to one indicates that the target shall enable the use of the most expedient form of error recovery, such as error correction, before applying retries. Seek or positioning retries and the recovery procedure retries of the message system are not affected by the value of this bit. Targets implementing error correction schemes that do not provide the most expedient form of error recovery should default to zero and report the EEC bit as not changeable in the MODE SENSE Page code 3. EEC and DCR both of one is an invalid request, for which the target shall create the Check Condition status with Illegal Request Sense Key.

An EEC bit set to zero, indicates that the target shall exhaust the defined retry limit prior to enabling error correction. If DCR bit is set to one, the defined retry limit only is to be performed.

The ECC bit is default to zero.

A **RC (Read Continuous)** bit 4 set to one requests the target to transfer the entire requested length of data without adding delays that would increase or ensure data integrity (ie. delays caused by the target's error recovery schemes). This implies that the target may send data which may be erroneous or fabricated in order to maintain a continuous flow of data and avoid delays.
The target shall assign priority to this bit over conflicting error control bits (EEC, DCR, DTE, PER) within this byte.
A **RC** bit set to zero, indicates that error recovery operations which cause reasonable delays are acceptable during the data transfer. Data shall not be fabricated.
The RC bit is reserved for C.D. ROM and defaults to zero.

Note that Apple has the additional requiremant that delays can only occur between transfer of two data blocks, but not within a data block.

A **TB(Transfer Block)** bit 5 set to one indicates that the failing data block (recovered or unrecoverable) data shall be transferred to the initiator. A **TB** bit set to zero indicates that the failing data block (recovered or unrecoverable) data shall not be transferred to the initiator.
Implementor Note: In both cases, but particularly when TB is zero, the block address reported in the REQUEST SENSE data shall be of the erring block, not of the preceding block.

The TB bit is default to zero.

The following table summarizes all valid modes of operation.

Value **Error Recovery Byte Bit Settings**

	Reserved	Reserved	TB	Reseved	EEC	PER	DTE	DCR
00			0		0	0	0	0
01			0		0	0	0	1
04			0		0	1	0	0
05			0		0	1	0	1
06			0		0	1	1	0
07			0		0	1	1	1
20			1		0	0	0	0
21			1		0	0	0	1
26			1		0	1	1	0
27			1		0	1	1	1

The following are the definitions of the errors reported by the C.D. ROM.

1) CIRC recovered data error : This error is defined as a data block for which the C2 flag was set, but on a subsequent read retry operations it was not set. The number of the subsequent read operations is limited to the read retry count (Byte 3 of the error recovery parameters page). L-ECC is not used in this case.

2) CIRC unrecovered data error : This error is defined as a data block for which the C2 flag was set on all read operation up to the read retry count. L-ECC is not used in this case.

3) L-ECC recovered data error : This error is defined as a data block for which C2 are asserted but the layered ECC was able to correct the error within the read retry count.

4) L-ECC uncorrectable data error : This error is defined as a data block which could not be corrected by the layered ECC within the read retry count.

Retry Count is the number of times that the target should attempt its read recovery algorithm according the setting of the DCR bit (the bit that enable/disable L-ECC). The Retry Count field is default to zero.

Recovery Time Limit is the maximum time that the target shall attempt error recovery actions to recover data. A zero value indicates that the time is unlimited. The Recovery Time Limit is set to 00H for C.D. ROM.

Error recovery procedures for the C.D. ROM Mode 1 data block.

Value of the error recovery byte	Description
00H	This is the default value of the error recovery byte. L-ECC is on. Only L-ECC uncorrectable data errors are reported. If an uncorrectable data error occurs, data transfer is terminated at the beginning of the first encountered uncorrectable block with a CHECK CONDITION status. The sense key is set to MEDIUM ERROR and the additional sense code is set to L-ECC UNCORRECTABLE DATA ERROR. The information bytes in the REQUEST SENSE command are set to the address of the first encountered uncorrectable block address.
04H	L-ECC is on. L-ECC recovered data block errors are reported. If an L-ECC recovered data error occurs, the data transfer is not terminated until all requested data blocks (including the L-ECC recovered data block) are transferred to the initiator. After the data transfer is completed, a CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR and the additional sense code is set to L-ECC RECOVERED DATA ERROR. The information bytes are set to the address of the last block for which an L-ECC recovered data error was detected. If an L-ECC uncorrectable data error occurs, data transfer is not terminated until all requested data blocks (including the L-ECC uncorrectable data block) are transferred to the initiator. After the data transfer is completed, a CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR and the additional sense code is set to L-ECC UNCORRECTABLE ERROR. The information bytes are set to the address of the last block for which an L-ECC uncorrectable error was detected.
06H	L-ECC is on. L-ECC recovered data errors are reported. If a L-ECC recovered data error occurs, data transfer is terminated at the beginning of the first encountered L-ECC recovered data block with a CHECK CONDITION status. The sense key is set to RECOVERED ERROR and the additional sense code is set to L-ECC RECOVERED DATA ERROR. The information bytes are set to the address of the first encountered L-ECC recovered error block. If an L-ECC uncorrectable data error occurs, data transfer is terminated at the beginning of the first encountered L-ECC uncorrectable data block with a CHECK CONDITION status. The sense key is set to MEDIUM ERROR and the additional sense code is set to L-ECC UNCORRECTABLE ERROR. The information bytes are set to the address of the first encountered L-ECC uncorrectable block.
26H	L-ECC is on. L-ECC recovered data errors are reported. This setting has the same function as the setting of 06H except that if a L-ECC recovered or an L-ECC uncorrectable data error occurs, data transfer is terminated at the end of the first encountered L-ECC recovered or L-ECC uncorrectable data block with a CHECK CONDITION status.
20H	L-ECC is on. Only L-ECC uncorrected data error are reported. If an L-ECC uncorrectable data block error occurs, the data transfer is not terminated until all requested data blocks (including the L-ECC uncorrectable data block) are transferred to the initiator. After the data transfer has completed, a CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR and tha additional sense code is set to L-ECC UNCORRECTABLE ERROR. The information bytes are set to the address of the last block for which an L-ECC uncorrectable data error was detected.

Error recovery procedures for the C.D. ROM Mode 1 and Mode 2 data block.

01H	L-ECC is not used. Only CIRC unrecovered data errors are reported. If an CIRC unrecovered data error occurs, data transfer is terminated at the beginning of the first encountered CIRC unrecovered data block with a CHECK CONDITION status. The sense key is set to MEDIUM ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR . The information bytes are set to the address of the first encountered CIRC unrecovered block address.
05H	L-ECC is not used. CIRC recovered data block errors are reported. If an CIRC recovered data block error occurs, the data transfer is not terminated until all requested data blocks (including the CIRC recovered data block) are transferred to the initiator. After the data transfer is completed, a CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR and the additional sense code is set to CIRC RECOVERED DATA ERROR. The information bytes are set to the address of the last block for which an CIRC recovered data error was detected. If a CIRC unrecoverable data error occurs, data transfer is not terminated until all requested data blocks (including the CIRC unrecovered data block) are transferred to the initiator. The sense key is set to MEDIUM ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR. The information bytes are set to the address of the last encountered CIRC unrecovered block.
07H	L-ECC is not used. CIRC recovered data errors are reported. If a L-ECC recovered data error occurs, data transfer is terminated at the beginning of the first encountered CIRC recovered data block with a CHECK CONDITION status. The sense key is set to RECOVERED ERROR and the additional sense code is set to CIRC RECOVERED DATA ERROR. The information bytes are set to the address of the first encountered CIRC recovered error block. If an CIRC unrecovered data error occurs, data transfer is terminated at the beginning of the first encountered CIRC unrecovered data block with a CHECK CONDITION status. The sense key is set to MEDIUM ERROR and the additional sense code is set to CIRC UNRECOVERED ERROR. The information bytes are set to the address of the first encountered CIRC unrecovered block.
27H	L-ECC is not used. CIRC recovered data errors are reported. This setting has the same function as the setting of 07H except that if a CIRC recovered or CIRC unrecovered data error occurs, data transfer is terminated at the end of the first encountered CIRC recovered or CIRC unrecovered data block with a CHECK CONDITION status.
21H	L-ECC is not used. Only CIRC unrecovered data error are reported. If an CIRC unrecovered data block error occurs, the data transfer is not terminated until all requested data blocks (including the CIRC unrecovered data block) are transferred to the initiator. After the data transfer has completed, a CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR and tha additional sense code is set to CIRC UNRECOVERED ERROR. The information bytes are set to the address of the last block for which an CIRC unrecovered data error was detected.

DISCONNECT/RECONNECT CONTROL PARAMETERS. Page code 2_H

Byte \ Bit	7	6	5	4	3	2	1	0
0	R	R	Page Code = 2_H					
1	Page Length (in bytes)							
2	Buffer Full Ratio							
3	Reserved							
4	Bus Inactivity Limit (MSB)							
5	Bus Inactivity Limit (LSB)							
6	Disconnect Time Limit (MSB)							
7	Disconnect Time Limit (LSB)							
8	Connect Time Limit (MSB)							
9	Connect Time Limit (LSB)							
10	Reserved							
11	Reserved							

Each ratio parameter is the numerator of a fractional multiplier that has 256 as its denominator.

Buffer Full Ratio indicates to the target, on READ commands, how full the buffer shall be prior to reconnecting.

The default value of the Buffer Full Ratio is 08H.

The relationship between the values of the buffer full ratio and the number of blocks are specified below.

Value of Buffer Full Ratio	Number of 2048 byte blocks	Number of 2336/2340 byte blocks	Value of Buffer Full Ratio	Number of 2048 byte blocks	Number of 2336/2340 blocks
00H	32	28			
01H - 08H	1	1	81H - 88H	17	15
09H - 10H	2	2	89H - 90H	18	16
11H - 18H	3	3	91H - 98H	19	17
19H - 20H	4	4	99H - A0H	20	18
21H - 28H	5	5	A1H - A8H	21	19
29H - 30H	6	6	A9H - B0H	22	20
31H - 38H	7	7	B1H - B8H	23	21
39H - 40H	8	8	B9H - C0H	24	21
41H - 48H	9	8	C1H - C8H	25	22
49H - 50H	10	9	C9H - D0H	26	23
51H - 58H	11	10	D1H - D8H	27	24
59H - 60H	12	11	D9H - E0H	28	25
61H - 68H	13	12	E1H - E8H	29	26
69H - 70H	14	14	E9H - F0H	30	27
71H - 78H	15	14	F1H - F8H	31	28
79H - 80H	16	15	F9H - FFH	32	28

Bus Inactivity Limit field (bytes 4 and 5) indicates the maximum time in 100 microseconds increments that the target is allowed to maintain the bus busy without handshakes until it shall disconnect. The target may round to its nearest capable value. A setting value of zero indicates that the target is allowed to maintain the bus busy indefinitely without handshakes until it determines to disconnect. **The default value for the Bus Inactivity Limit field is 00H.**

Disconnect Time Limit field (bytes 6 and 7) indicates the minimum time in 100 microseconds increments that the target should remain disconnected until it attempts to reconnect. The target may round to its nearest capable value. A setting value of zero indicates that the target is allowed to reconnect immediately. **The default value for Disconnect Time Limit field is 00H.**

Connect Time Limit field (bytes 8 and 9) indicates the maximum time in 100 microseconds increments that the target should remain connected until it attempts to disconnect. The target may round to its nearest capable value. A setting value of zero indicates that the target is allowed to remain connected indefinitely until it determines to attempt disconnection. **The default value for Connect Time Limit field is 00H.**

DRIVE PARAMETERS. Page code 20_H.

Bit Byte	7	6	5	4	3	2	1	0
0	R	R	Page Code=20_H					
1	Page Length (in bytes) = 02H							
2	Rsvd.	Rsvd.	Rsvd.	Rsvd.	Rsvd.	Rsvd	Rsvd	Rsvd
3	Reserved				Inactivity Time-Out			

The Inactivity Time-Out byte is used by the initiator to set the time-out value to spin-down the medium and turn off the laser when the drive is inactive (for both data and audio operation). The drive will remain in the hold track state after completion of a seek or read operation during the inactivity time-out period. The time-out value is the value of this 4-bit field times 2 minutes. A 0H in this field will turn on the drive infinitely. The default value of the Inactivity Time-Out byte is 5_H which means the drive will turn off in approximately 10 minutes from the time when the drive enters a hold track state following a seek or read operation.

8.1.8 RESERVE UNIT Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 16_H

Table 8-15
RESERVE UNIT Commands

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			3rdParty	Third Party device ID			Extent
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

RESERVE UNIT Command. The RESERVE UNIT command (Table 8-15) is used to reserve the specified logical unit for the exclusive use by the requesting initiator or, if the third-party reservation is requested, to another specified SCSI device. The implementation of the EXTENT bit is not required.

The reservation shall remain in effect until superceded by another RESERVE UNIT command from the initiator that made the reservation or uintil released by a RELEASE UNIT command from the same initiator, or a BUS DEVICE RESET message from any initiator, or a "hard" RESET condition. The occurance of the last two conditions is indicated by a sense key of UNIT ATTENTION on the next command following the condition. It is not an error to issue this command to a logical unit that is currently reserved to the requesting initiator.

If the logical unit is previously reserved by another initiator, then the target shall return a RESERVATION CONFLICT status.

If, after honoring the reservation, any other initiator then subsequently attempts to perform any command on the reserved logical unit other than a RESERVE UNIT command, or a RELEASE UNIT command(which shall be ignored), then the command shall be rejected with a RESERVATION CONFLICT status.

The third-party reservation for the RESERVE UNIT command allows an initiator to reserve a logical unit for another SCSI device(initiator). This is intended for use in multiple-initiator systems.

If the third-party (3rdParty) bit is zero, then third-party reservation is not requested. If the 3rdParty bit is one, then the RESERVE UNIT command shall reserve the specified C.D. ROM unit for the SCSI device specified in the third-party device ID field. The target shall preserve the reservation until superceded by another RESERVE UNIT command from the initiator that made the reservation or until released by the same initiator, by a BUS DEVICE RESET message from any initiator, or by a "hard" RESET condition. The target shall ignore (i.e., return GOOD status) any attempt made by any other initiator to release the reservation.

An initiator that holds a current reservation may modify that reservation (e.g., switch third-parties) by issuing another RESERVE UNIT command to the same logical unit (C.D. ROM). The superceding RESERVE UNIT command shall release the previous reservation state only when the new reservation is granted.

8.1.9 RELEASE UNIT Command.

Peripheral Device Type:	C.D. ROM
Operation Code Type:	Mandatory
Operation Code:	17_H

Table 8-17
RELEASE UNIT Commands

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			3rdParty	Third Party device ID			Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

The RELEASE UNIT Command (Table 8-17) is used to release the logical unit if it is currently reserved by the requesting initiator.

It is not an error to attempt to release a logical unit that is not currently reserved to the requesting initiator. However, it shall not be released if it is reserved by another initiator.

The third-party release for the RELEASE UNIT command allows an initiator to release a logical unit that was previously reserved using the third-party reservation option (see 8.1.8).

If the third-party (3rdParty) bit is zero then the third-party release option is not requested. If the third-party bit is one, then the target shall release the specified logical unit, but only if the reservation was made using third-party reservation by the initiator that is requesting the release and for the same SCSI device as specified in the third-party device ID field.

8.1.10 MODE SENSE Command

Peripheral Device Type:	C.D. ROM
Operation Code Type:	Mandatory
Operation Code:	$1A_H$

Table 8-18
MODE SENSE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	**PCF**		**Page Code**					
3	Reserved							
4	Allocation Length							
5	VU		Reserved				Flag	Link

The MODE SENSE command (Table 8-18) provides a means for a target to report its medium, logical unit, or peripheral device parameters to the initiator. It is a complementary command to the MODE SELECT command (see 8.1.7).

The PCF (Page Control Field) bits 7 and 6 of byte 2 defines the type of Page Parameter values to be returned.

B(7)B(6)	Type of Parameter values
00	Current Values
01	Changeable Values
10	Default Values
11	Default Values

(Since C.D. ROM is not writable, parameter values can not be saved. A 11B in bit 7 and bit 6 of byte 2 shall return default values

Current Values
The current values returned are either the parameters set in the last sucessful MODE SELECT command or the default values if a MODE SELECT command has not been executed.

Changeable Values
The pages requested will be returned with the bits that are allowed to be changed set to one. Parameters that are not changeable will be set to zero. I f any part of a field is changeable, all bits in that field are set to one.
The page descriptor as defined in this document will always be returned even if none of the parameters are changeable within the page.

Default Values.
Pages requested will be returned to the initiator with the fields or bits set to the default values. Fields and bits not supported by the target shall be set to zero.

The Page Code bits 5 through 0 of byte 2 indicates which Page(s) to return. If the page code is 3FH, all implemented pages are requested to be returned by the target.

Page Codes (bits 0 through 5 of byte 2)

Page Code	Meaning
0_H	**Unit Attention**
1_H	**Error Recovery parameters**
2_H	**Disconnect/Reconnect Control parameters**
20_H	**Drive Parameters**
$3F_H$	**Return all Pages to the initiator.**

The allocation length specifies the number of bytes that the initiator has allocated for returned MODE SENSE data. An allocation length of zero indicates that no MODE SENSE data shall be transferred. This condition shall not be considered as an error. Any other value indicates the maximum number of bytes that shall be transferred. The target shall terminate the DATA IN phase when allocation length bytes have been transferred or when all available MODE SENSE data have been transferred to the initiator, whichever is less.

The MODE SENSE data (Table 8-19) contains a four-byte header, followed by one eight-byte block descriptors, **followed by zero or more Pages.**

Table 8-19
MODE SENSE Data

Mode Sense Header

Bit Byte	7	6	5	4	3	2	1	0
0	Sense Data Length							
1	Medium Type=00H							
2	WP	Reserved						
3	Block Descriptor Length = 08H							

Block Descriptor(s)

0	Reserved							
1	Number of Blocks (MSB)							
2	Number of Blocks							
3	Number of Blocks (LSB)							
4	Reserved							
5	Block Length (MSB)							
6	Block Length							
7	Block Length (LSB)							

Page Descriptor(s)

0	PS=0	R	Page Code					
1	Page Length (in bytes)							
2 to n	Refer to Page definition in MODE SELECT							

The Sense Data Length byte specifies the length in bytes of the following MODE SENSE data that is available to be transferred during the DATA IN phase. The Sense Data Length byte shall not include itself. **If the Allocation Length of the CDB is too small to transfer all the sense data, the Sense Data Length shall not be adjusted to reflect the truncation.**

Medium Type should be 00H for C.D. ROM disc.

WP (Write Protected) bit is reserved for C.D. ROM.

The block descriptor length specifies the length in bytes of one block descriptor, therefore this field should be set to 08H.

The number of blocks field specifies the number of logical blocks on the medium that meet the block length in the Block Descriptor. A 00H in all the number of blocks fields specifies all the logical blocks of the logical unit. The Block Length specifies the length in bytes of each logical blocks. Block Length of 256(100H), 512(200H), 1024(400H), 2048(800H), 2052(804H, optional), 2336(920H) ,2340(924H), or 2352(930H, optional) bytes are supported by the target. The default block length is 2048 bytes.

Pages are returned following zero or one block descriptor if requested. Each page has a header defining the page code and the page length. Following the header are page parameters. The page length value is the number of bytes that follow the page length byte and does not include the header. The pages are defined under the MODE SELECT command.

The initiator shall issue a MODE SENSE command requesting the target to return all Changeable values (PCF field configuration 01B and Page Code 3FH in byte 2 of the MODE SENSE CDB) prior to issuing any MODE SELECT commands, in order to find out which Pages are implemented by the target and the length of each Pages for that particular target.

An initiator may request a particular Page to be returned by the target by selecting its code in byte 2 of the CDB.

8.1.11 START/STOP UNIT Command.

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $1B_H$

Table 8-20
START/STOP UNIT Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved							Start
5	Vendor Unique		Reserved				Flag	Link

The START/STOP UNIT Command (Table 8-20) requests that the target enable or disable the logical unit for further operation.

An immediate (Immed) bit of one indicates that the status shall be returned as soon as the operation is initiated. An Immed bit of zero indicates that status shall be returned after the operations. If the Immediate bit is zero and the initiator supports disconnect/reconnect, the command will disconnect while performing the command.

A start bit of one requests the logical unit be made ready for use (i.e. the drive will spun up and the laser beam, focus servo and tracking servo are put into on state). A start bit of zero requests that the logical unit be stopped (i.e. the drive will spun down and the laser beam, focus servo and tracking servo are put into off state).

7.1.5 RECEIVE DIAGNOSTIC RESULTS Command.

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $1C_H$

Table 7-18
RECEIVE DIAGNOSTIC RESULTS Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	Vendor Unique		Reserved				Flag	Link

The RECEIVE DIAGNOSTIC RESULTS Command (Table 7-18) requests analysis data be sent to the initiator after completion of a SEND DIAGNOSTIC command.

The allocation length shall specify the number of bytes that the initiator has allocated for returned diagnostic data. An allocation length of zero indicates that no diagnostic data shall be transferred. Any other value indicates the maximum number of bytes that shall be tranferred. The target terminates the DATA IN phase when allocation length bytes have been transferred or when all available diagnostic data have been transferred to the initiator, whichever is less.

The diagnostic data returned is vendor unique. The following is an implementation example.

The RECEIVE DIAGNOSTIC data contains an eight-byte parameter list defined as follows.

Table 7-18-1
Receive Diagnostic Data

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Parameter Length (06H)							
2	ROM Diagnostic							
3	RAM Diagnostic							
4	Data Buffer Diagnostic							
5	Interface Diagnostic							
6	Reserved							
7	Reserved							

The parameter length specifies the length in bytes of the following Receive Diagnostic parameters. The parameter length does not include itself. Since there are six bytes following the parameter length byte, the parameter length byte is set to 06H.

A value of zero in any bit of a diagnostic field indicates that the diagnostic if requested passed.

If bit 0 of the ROM Diagnostic field is set to one, it indicates that the controller ROM has failed. If the bit 1 of the ROM Diagnostic field is set to one, it indicates that the drive control ROM has failed.

If bit 0 of the RAM Diagnostic field is set to one, it indicates that the controller RAM has failed. If the bit 1 of the RAM Diagnostic field is set to one, it indicates that the drive control RAM has failed.

If bit 0 of the Data Buffer Diagnostic field is set to one, it indicates that the controller data buffer has failed. If the bit 1 of the Data Buffer Diagnostic field is set to one, it indicates that the drive control data buffer has failed. If the bit 2 of the Data Buffer Diagnostic field is set to one, it indicates that the drive control error RAM has failed.

If the bit 0 of the Interface Diagnostic field is set to one, it indicates that the controller/drive control interface has failed. If the bit 1 of the Interface Diagnostic field is set to one, it indicates that the drive control /mechanism control interface has failed.

7.1.6 SEND DIAGNOSTIC Command.

Peripheral Device Type:	C.D. ROM
Operation Code Type:	Mandatory
Operation Code:	$1D_H$

Table 7-19
SEND DIAGNOSTIC Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved		SelfTest	Reserved	
2	Reserved							
3	Parameter List Length (MSB)							
4	Parameter Liat Length (LSB)							
5	Vendor Unique		Reserved				Flag	Link

The SEND DIAGNOSTIC Command (Table 7-19) requests the controller to perform diagnostic tests on itself, on the attached periperal devices, or both. Except when the self-test bit is one , this command is usually followed by a RECEIVE DIAGNOSTIC RESULTS command.

A SelfTest bit of one directs the controller to complete its default self-test. If the self-test is requested, the parameter list length shall be set to zero. If the self-test bit is set to one and the parameter list length is not zero, the command will be terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB. The controller may not disconnect during self-test .

If the self-test does not fail, the command will be terminated with a GOOD status; otherwise, the command will be terminated with a CHECK CONDITION status and the sense key will be set to HARDWARE ERROR.

The parameter list length specifies the length in bytes of the parameter list that will be transferred during the DATA OUT phase. A parameter list length of zero indicates that no data will be transferred. This condition will not be considered as an error.

If the self-test is not requested the controller will return GOOD status upon receiving a valid command descriptor block and parameter list. The parameter list length is set to eight if user specifed diagnostics are requested. The results of the diagnostic test are returned to the initiator by a RECIEVE DIAGNOSTIC RESULTS command.

The send diagnostic data in the DATA OUT phase is vendor unique. The following is an implementation example.

The SEND DIAGNOSTIC data contains an eight-byte parameter list defined as follows.

Table 7-19-1
Send Diagnostic Data

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Parameter Length (06H)							
2	ROM Diagnostic							
3	RAM Diagnostic							
4	Data Buffer Diagnostic							
5	Interface Diagnostic							
6	Reserved							
7	Reserved							

The parameter length specifies the length in bytes of the following Send Diagnostic parameters. The parameter length does not include itself. Since there are six bytes following the parameter length byte, the parameter length byte should be set to 06H.

A value of zero in any bit of a diagnostic field indicates that the diagnostic associated with the bit field is not requested. A one in any bit of a diagnostic field indicates that the diagnostic associated with the bit field should be performed by the drive.

Bit 0 and bit 1 of the ROM Diagnostic field are used for checking the controller ROM and the drive control(CDC) ROM respectively. Bit 2 to bit 7 of the ROM Diagnostic field should be set to 0.

Bit 0 and bit 1 of the RAM Diagnostic field are used for checking the controller RAM and the drive control(CDC) RAM respectively. Bit 2 to bit 7 of the RAM Diagnostic field should be set to 0.

Bit 0 ,bit 1 and bit 2 of the Data Buffer Diagnostic field are used for checking the controller data buffer , the drive control(CDC) data buffer and the drive control(CDC) error RAM respectively. Bit 3 to bit 7 of the Data Buffer Diagnostic field should be set to 0.

Bit 0 and bit 1 of the Interface Diagnostic field is used for checking the controller/drive control (i.e. controller to CDC)interface and the drive control/mechanism (i.e. CDC to CDD) interface respectively. Bit 2 to bit 7 of the Interface Diagnostic field should be set to 0.

8.1.12 PREVENT/ALLOW MEDIA REMOVAL Command.

Peripheral-Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $1E_H$

This command requests that the target enable/disable the removal of the cartridge in the drive. A prevent bit of one will inhibit the removal of the cartridge by using the eject disk command or by use of the eject button. The emergency pin hole eject mechanism will not be overridden. If the initiator issues EJECT DISK command with the PREVENT bit of this command set to one, the EJECT DISK command will have CHECK CONDITION status with the sense key of illegal request and the additioal sense code of 80H (vendor unique) for prevent media removal. Prevention of the cartridge removal condition will be terminated upon receipt of a BUS DEVICE RESET message or a hard reset. Refer to section 8.1.12 of ANSI X3T9.2/82-2 Rev. 17B for details.

2.5.2 Group 1 Commands for C.D. ROM Devices The Group 1 commands for C.D. ROM devices shall be as shown in Table 2.5.2-1.

Table 2.5.2-1
Group 1 Commands for C.D. ROM Devices

Operation Code	Type	Command Name	Section
20_H	R		
21_H	R		
22_H	R		
23_H	R		
24_H	R		
25_H	M	READ CAPACITY	8.2.1
26_H	R		
27_H	R		
28_H	M	READ EXTENDED	12.2.1
29_H	R		
$2A_H$	R		
$2B_H$	M	SEEK EXTENDED	8.2.4
$2C_H$	R		
$2D_H$	R		
$2E_H$	R		
$2F_H$	M	VERIFY	12.2.4
30_H	R		
31_H	R		
32_H	R		
33_H	R		
34_H	R		
35_H	R		
36_H	R		
37_H	R		
38_H	R		
39_H	R		
$3A_H$	R		
$3B_H$	M	WRITE BUFFER	CCS(X3T9.2/85-52)
$3C_H$	M	READ BUFFER	CCS(X3T9.2/85-52)
$3D_H$	R		
$3E_H$	R		
$3F_H$	R		

Key: M = Command implementation is Mandatory
E = Command implementation is Required for SCSI devices that support device independent self-configuring software.
O = Command implementation is Optional.
R = Command code is reserved for future standardization.
V = Command code is available for Apple unique commands.

8.2.1 READ CAPACITY Command.

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 25_H

The READ CAPACITY command requests that the target controller determine the physical size of the currently mounted C.D. ROM disc.

The logical block address bytes, PMI (partial medium indicator) bit and RelAdr (relative address) bit are set to zero in this command.

The target sends eight bytes to the initiator during the data transfer phase. The first four bytes is the logical block address of the last valid logical block address on the medium. The second four bytes is the block length in bytes of the logical block on this disc. The logical block address and the block length are based on the value of the block length set in the Mode Select parameter. The block length is default to 2048 bytes. Refer to section 8.2.1 of ANSI X3T9.2/82-2 for details.

12.2.1 READ EXTENDED Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: 28_H

After the read the optical pickup is in a HOLD TRACK state for the duration of the inactivity time-out. Refer to section 12.2.1 of ANSI X3T9.2/82.2 Rev. 17B for details.

8.2.4 SEEK EXTENDED Command

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $2B_H$

After the seek the optical pickup is in a HOLD TRACK state for the duration of the inactivity time-out. Refer to section 8.2.4 of ANSI X3T9.2/82.2 Rev. 17B for details.

12.2.4 VERIFY Command.

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $2F_H$

Table 12-12
VERIFY Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved		BlkVfy=0	BytChk=0	RelAdr =0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Verification Length (MSB)							
8	Verification Length (LSB)							
9	Vendor Unique		Reserved				Flag	Link

The VERIFY command (Table 12-12) requests that the target verify the data on the medium based on the error recovery parameters setting. This command provides a mean to verify the medium without transfering data through the SCSI bus.

The BlkVfy (blank verify) bit and the RelAdr (relative address) bit are set to zero.

A BytChk (byte check) bit of zero causes medium verification. The layered ECC is enable/disable during the verification based on the parameter set by the mode select command. The block length should be set to 2048 or 2336 bytes in the mode select command. A BytChk bit of one causes a byte-by-byte compare of the data on the medium and the data transferred from the initiator. Implementation of the byte-by-byte compare (BytChk=1) is not required for C.D. ROM.

The logical block address specifies the logical block at which the verification operation shall begin.

The verification length specifies the number of contiguous logical blocks of data that shall be vertified. A verification length of zero indicates that no logical blocks shall be verified. This condition shall not be considered as an error. Any other value indicates the number of logical blocks that shall be verified.

2.5.2.1 WRITE BUFFER Command.

Peripheral Device Type:	C.D. ROM
Operation Code Type:	Mandatory
Operation Code:	$3B_H$

Table 2.5.2.1-1
WRITE BUFFER Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved			Mode	
2	Reserved							
3	Buffer Offset (M.S. byte)							
4	Buffer Offset							
5	Buffer Offset (L.S. byte)							
6	Transfer Length (M.S. byte)							
7	Transfer Length (data length + 4 header bytes)							
8	Transfer Length (L.S. byte)							
9	Vendor Unique		Reserved				Flag	Link

The WRITE BUFFER command (Table 2.5.2.1-1) is used in conjunction with the READ BUFFER command as a diagnostic function for testing the target's buffer memory and the SCSI bus integrity. There shall be no access to the medium during the execution of this command.

Data to be transferred is preceded by a four-byte header. The four-byte header consists of all reserved bytes as shown in the following diagram. The WRITE BUFFER header is sent as part of the data transfer phase to the controller. The purpose is to make the READ BUFFER transfers equivalent in byte count.

Write Buffer Header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field.

Mode Field	Description
00B	Combined header and data with buffer offset set to zero.
01B	Combined header and data with the buffer offset specifies the byte offset within the buffer where the data will be stored.
10B	Reserved.
11B	Reserved.

The buffer offset is the byte offset within the buffer where the data will be stored. If the controller is unable to accept the specified buffer offset, it will return CHECK CONDITION status and it will set the sense key to ILLEGAL REQUEST. If the mode field is set to 00B and the buffer offset field is set to nonzero value, the drive will return Check Condition.

The transfer length specifies the maxium number of bytes that will be transferred during the DATA OUT phase. This number includes four bytes of header, so the data length to be stored in the target's buffer is transfer length minus four. The initiator should attempt to ensure that the transfer length is not greater than four plus the available length that is returned in the header of the READ BUFFER command. If the transfer length exceeds the available length plus four, the controller will return CHECK CONDITION status and will set the sense key to ILLEGAL REQUEST. If the buffer offset plus the transfer length is greater than 64K+4, the drive will generate a Check Condition.

2.5.2.2 READ BUFFER Command.

Peripheral Device Type: C.D. ROM
Operation Code Type: Mandatory
Operation Code: $3C_H$

Table 2.5.2.2-1
READ BUFFER Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved			Mode	
2	Reserved							
3	Buffer offset (M.S. byte)							
4	Buffer offset							
5	Buffer offset (L.S. byte)							
6	Allocation Length (M.S. byte)							
7	Allocation Length (4 header bytes + data length)							
8	Allocation Length (L.S. byte)							
9	Vendor Unique		Reserved				Flag	Link

The READ BUFFER command (Table 2.5.2.2-1) is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing the target's buffer memory and the SCSI bus integrity. There shall be no access to the medium during the execution of this command.

A four-byte header followed by data bytes are returned to the initiator during the DATA IN phase. The read buffer header is defined below.

Read Buffer Header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Available Length (M.S. byte)							
2	Available Length							
3	Available Length (L.S. byte)							

The available length specifies the total number of data bytes that are available in the target's data buffer. The number is not reduced to reflect the allocation length nor is it reduced to reflect the actual number of bytes written using the WRITE BUFFER command. Following the READ BUFFER header, the target shall transfer data from its data buffer. The number of data bytes transferred following the READ BUFFER header shall be the lesser of allocation length minus four or available length. The buffer offset field plus the available length field is always equal to 64K.

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field.

Mode Field	Description
00B	Combined header and data with buffer offset set to zero.
01B	Combined header and data with the buffer offset specifies the byte offset within the buffer where the data will be read.
10B	Reserved.
11B	Reserved.

The buffer offset is the byte offset within the buffer where the data will be read. If the controller is unable to accept the specified buffer offset, it will return CHECK CONDITION status and it will set the sense key to ILLEGAL REQUEST. If the mode field is set to 00B and the buffer offset field is set to nonzero value, the drive will return Check Condition.

The allocation length specifies the maxium number of bytes that the initiator has allocated for returned header and data. An allocation length of zero indicates that no header or data shall be transferred. Any other value indicates the maximum number of bytes that shall be transferred. The target terminates the DATA IN phase when allocation length bytes of header plus data have been transferred or when all available header and data have been transferred to the initiator, whichever is less.

2.5.3 Group 6 Commands for CD-Rom Devices The Group 6 commands for CD-Rom devices shall be as shown in Table 2.5.3-1.

Table 2.5.3-1
Group 6 Commands for CD-Rom Devices

Operation Code	Type	Command Name	Section
$C0_H$	M	EJECT DISC	2.5.3.1
$C1_H$	M	READ TOC	2.5.3.2
$C2_H$	M	READ Q SUBCODE	2.5.3.3
$C3_H$	M	READ HEADER	2.5.3.4
$C4_H$	R		
$C5_H$	R		
$C6_H$	R		
$C7_H$	R		
$C8_H$	M	AUDIO TRACK SEARCH	2.5.3.5
$C9_H$	M	AUDIO PLAY	2.5.3.6
CA_H	M	AUDIO PAUSE	2.5.3.7
CB_H	M	AUDIO STOP	2.5.3.8
CC_H	M	AUDIO STATUS	2.5.3.9
CD_H	M	AUDIO SCAN	2.5.3.10
CE_H	R		
CF_H	R		

Key: M = Command implementation is Mandatory
E = Command implementation is Required for SCSI devices that support device independent self-configuring software.
O = Command implementation is Optional.
R = Command code is reserved for future standardization.
V = Command code is available for vendor unique commands.

2.5.3.1 EJECT DISC Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: $C0_H$

Table 2.5.3.1-1-6
EJECT DISC Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				IMMED
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved		Reserved				Flag	Link

The EJECT DISC command (Table 2.5.3.1-1) specifies for the CD-Rom to eject the disc cartridge.

- IMMED BIT: Function specifies when status of EJECT DISC is returned.
  IMMED BIT = 0: After completion of command execution, CD-ROM returns status.
  IMMED BIT = 1: Before completion, immediately, CD-ROM returns status.

2.5.3.2 READ TOC Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: $C1_H$

Table 2.5.3.2-1
READ TOC Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number (TNO in BCD)							
6	Reserved							
7	Allocation Length (M.S. byte)							
8	Allocation Length (L.S. byte)							
9	TYPE		Reserved				Flag	Link

This command transfers TOC (Table of contents) data from the CD disc to the initiator.

- Track Number(TNO) specifies the starting track number in BCD for the cases when the TYPE=10B. The starting track ranges from 01 to 99 in BCD. The TNO byte is reserved for TYPE=00B, 01B or 11B.
  When specifying the track number larger than the last TNO or when specifying the track number smaller than the first TNO, the check condition status is returned.

- The allocation length specifies the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The target terminates the DATA IN phase when allocation length bytes have been transferred or when all available data has been transferred to the initiator, whichever is less.

TYPE	Description
00 B	Transfers the first and last user track number in BCD.
01 B	Transfers the starting address of the Lead out area in BCD MIN-SEC-FRAME format.
10 B	Transfers the starting address of each track for a range of tracks starting from the track specified in the TNO byte in ascending sequential order until the number of bytes specified in the allocation length have been transferred or when all available data has been transferred to the initiator, whichever is less.
11 B	Reserved.

(i) TYPE = 00B

This format transfers the first and last user track number in BCD.

Table 2.5.3.2-2 Read TOC Data (TYPE = 00B)

Bit / Byte	7	6	5	4	3	2	1	0
0	The first user track number (TNO) in BCD							
1	The last user track number (TNO) in BCD							
2	Reserved							
3	Reserved							

(ii) TYPE = 01B

This format transfers the starting address of the Lead out area in BCD MIN-SEC-FRAME format.

Table 2.5.3.2-3 Read TOC Data (TYPE=01B)

Bit / Byte	7	6	5	4	3	2	1	0
0	Lead-out area starting address in BCD (MIN)							
1	Lead-out area starting address in BCD (SEC)							
2	Lead-out area starting address in BCD (FRAME)							
3	Reserved							

(iii) TYPE = 10B

This format transfers the starting address information (i.e. control field, MIN, SEC and FRAME) of each track for a range of tracks starting from the track specified in the TNO byte in ascending sequential order until the number of bytes specified in the allocation length have been transferred or when all available data has been transferred to the initiator, whichever is less.

Table 2.5.3.2-4 Read TOC Data (TYPE=10B)

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Control field of a specified track			
1	Starting point of a specified track (MIN in BCD)							
2	Starting point of a specified track (SEC in BCD)							
3	Starting point of a specified track (FRAME in BCD)							

The above four-byte starting address information is repeated for each track in a range of tracks.

(iv) TYPE = 11B: Reserved.

The following is the read TOC strategy after a power up or disk change. In addition the drive should not read the TOC again after a hard reset from the SCSI bus.

1) CD ROM drive returns the Check Condition status when any command is sent from the host during the TOC read.

2) CD ROM drive returns a sense key "Not Ready" and an additional sense code of B7(Read TOC in progress) when host does Request Sense after check condition as stated in item 1 above.

3) If the drive is unable to read the TOC in the maximum interval allowed by the Yellow Book, then the drive gives a check condition followed by a sense key of "Not Ready" and an additional sense code "Unable to recover TOC" (B1).

4) The Read TOC command will not force the drive to reattempt to read the TOC unless there has been a disc change or a power up.

2.5.3.3 READ Q SUBCODE Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: $C2_H$

Table 2.5.3.3-1
READ Q SUBCODE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Allocation Length							
9	Reserved						Flag	Link

This command (Table 2.5.3.3-1) transfer the current Q SUBCODE ADDRESS loaded from either audio or data track to the initiator.

When the CD-Rom is not in READY state, a check condition is returned.

The allocation length specifies the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The target terminates the DATA IN phase when allocation length bytes have been transferred or when all available data has been transferred to the initiator, whichever is less.

Table 2.5.3.3-2 Format of Q SUBCODE data.

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Control Field			
1	CD SUBCODE Q ADDRESS data (Trk No)							
2	CD SUBCODE Q ADDRESS data (X)							
3	CD SUBCODE Q ADDRESS data (MIN)							
4	CD SUBCODE Q ADDRESS data (SEC)							
5	CD SUBCODE Q ADDRESS data (FRAME)							
6	CD SUBCODE Q ADDRESS data (AMIN)							
7	CD SUBCODE Q ADDRESS data (ASEC)							
8	CD SUBCODE Q ADDRESS data (AFRAME)							

The Control Field is defined as follows.

BIT 3	2	1	0	Content
0	0	X	0	2 Audio Channels WITHOUT Pre-Emphasis
0	0	X	1	2 Audio Channels WITH Pre-Emphasis
1	0	X	0	4 Audio Channels WITHOUT Pre-Emphasis
1	0	X	1	4 Audio Channels WITH Pre-Emphasis
0	1	X	0	Data Track
0	1	X	1	Reserved
1	1	X	X	Reserved
X	X	0	X	Digital Copy Prohibited
X	X	1	X	Digital Copy Permitted

The track number specifies the current track number in BCD notation. The value of this has a range of 01 to 99.

The Index Number(X) specifies the index number in the current track.

The MIN, SEC and FRAME fields specifies the relative running time from the beginning of the track.

The AMIN, ASEC and AFRAME fields specifies the relative running time from the beginning of the disc.

2.5.3.4 READ HEADER Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: $C3_H$

Table 2.5.3.4-1
READ HEADER Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Allocation Length							
9	Reserved		Reserved				Flag	Link

This command returns four bytes of header information of the specified logical block address. This command is similar to the READ EXTENDED command, but only the header bytes are returned to the initiator.

System or application program can find out the mode of the block more easily with this command.

If the logical block address is within an audio track, a CHECK CONDITION will be reported in the status phase.

The allocation length specifies the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The target terminates the DATA IN phase when allocation length bytes have been transferred or when all available data has been transferred to the initiator, whichever is less.

Table 2.5.3.4-2 HEADER DATA

Bit / Byte	7	6	5	4	3	2	1	0
0	CD-absolute time (A MIN)							
1	CD-absolute time (A SEC)							
2	CD-absolute time (A FRAME)							
3	Mode							

2.5.3.5 AUDIO TRACK SEARCH Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: $C8_H$

Table 2.5.3.5-1
AUDIO TRACK SEARCH Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Play	Play Mode			
2	Search Address (MSB)							
3	Search Address							
4	Search Address							
5	Search Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	TYPE		Reserved				Flag	Link

The AUDIO TRACK SEARCH command (Table 2.5.3.5-1) provides a means for positioning the optical pickup at address specified by the Search Address parameter. This command returns the status byte when the requested search address is found. If the search address is not found, or if the drive is not ready, or if the search address is not within an audio track, a CHECK CONDITION status will be returned.

A PLAY bit of zero indicates the drive will enter the hold track state (i.e. pause) when the search address is found. The music will then be played back when a AUDIO PLAY command is issued. A PLAY bit of one indicates the drive will output the audio channels in the specified Play Mode when the audio address is found.

The drive can accept and perform another command which will or will not terminate the current audio play operation as described in the underlined section under the AUDIO PAUSE command description.

PLAY-MODE (Byte 01, bits 3 to 0) specifies the play mode as follows:

(i) PLAY-MODE = 0000B: Play with MUTING on.
(ii) PLAY-MODE = 0001B: Play R-channel only thru R-channel only.
(iii) PLAY-MODE = 0010B: Play L-channel thru R-channel only.
(iv) PLAY-MODE = 0011B: Play L/R channels thru R-channel only.
(v) PLAY-MODE = 0100B: Play R-Channel thru L-channel only.
(vi) PLAY-MODE = 0101B: Play R-chan thru L, R-chan to R-chan.
(vii) PLAY-MODE = 0110B: Play R thru L, L thru R.
(viii) PLAY-MODE = 0111B: Play R thru L, L/R thru R.
(ix) PLAY-MODE = 1000B: Play L channel thru L-channel only.
(x) PLAY-MODE = 1001B: Play L-channel thru L, R thru R, STEREO.
(xi) PLAY-MODE = 1010B: Play L-chan thru L, L-chan to R-chan.
(xii) PLAY-MODE = 1011B: Play L thru L, L/R thru R-channel.
(xiii) PLAY-MODE = 1100B: Play L/R thru L-channel.
(xiv) PLAY-MODE = 1101B: Play L/R thru L, R thru R-channel.
(xv) PLAY-MODE = 1110B: Play L/R thru L-channel, L thru R-channel.
(xvi) PLAY-MODE = 1111B: Play L/R thru L-channel, L/R thru R-channel.

The mnemonic for understanding the PLAY-MODE bits is: the right two bits (bits 1 and 0) stand for the speaker right channel output from left and right channels input; the left two bit (bits 3 and 2) stand for the speaker left channel output from left and right channels input.

The TYPE field specifies the format of the Search Address used in the command. The TYPE field is defined below.

TYPE FIELD	Description
00 B	Specifies SEARCH address in logical block address format.
01 B	Specifies SEARCH address in AMIN, ASEC and AFRAME format.
10 B	Specifies SEARCH address in track number (TNO) format.
11 B	Reserved.

Table 2.5.3.5-2 Search Address in Logical Block Address format

Bit Byte	7	6	5	4	3	2	1	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							

The logical block address specifies the logical block address at which the play or pause operation will begin.

Table 2.5.3.5-3 Search Address in AMIN, ASEC and AFRAME format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-absolute time (AMIN)							
4	CD-absolute time (ASEC)							
5	CD-absolute time (AFRAME)							

The AMIN, ASEC and AFRAME fields specifies the relative running time from the beginning of the disc. The AMIN field has a range of 00 to 99 in BCD. The ASEC ranges from 00 to 59 in BCD. The AFRAME field has a range of 00 to 74 in BCD.

Table 2.5.3.5-4 Search Address in Track Number (TNO) format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number (TNO)							

The Track Number field specifies the track in BCD notation at which the play or pause operation will begin. This field has a range of 01 to 99 in BCD.

2.5.3.6 AUDIO PLAY Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: $C9_H$

Table 2.5.3.6-1
AUDIO PLAY Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			StopAddr	PLAY MODE			
2	Playback address (MSB)							
3	Playback address							
4	Playback address							
5	Playback address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	TYPE		Reserved				Flag	Link

The AUDIO PLAY command (Table 2.5.3.6-1) request that the target position the optical pickup at the Playback address specified and output the audio channels in the specified Play Mode when the Playback Address is found. This command returns the status byte when the Playback Address is found. If the Playback Address is not found, or if the drive is not ready, or if the address is not within an audio track, a CHECK CONDITION status will be returned.

The AUDIO PLAY command is used to release a PAUSE(hold track) state after the execution of AUDIO TRACK SEARCH command or a PAUSE state after the execution of an AUDIO PAUSE command. The AUDIO PLAY command can also be used to set a particular completion address or PLAY MODE.

A Stop Address (StopAddr) bit of zero indicates that the playback address is the starting address for the audio play operation. In this case, the stop address should be set by a prior AUDIO STOP command. A Stopaddr bit of one indicates that the playback address is the stopping address of the audio play operation. In this case, the starting address is set by a prior AUDIO TRACK SEARCH command. In both cases, if the stopping address is larger than the end of the current audio track, the drive should play up to the stop address or until it encounters a data track. The stop address is default to be the last audio track after power up or media change. If the stop address is smaller than the starting address, the drive will return a CHECK CONDITION with Illegal Request sense key and should not play any audio. The minimum difference between the audio start address and the audio stop address is 25 blocks.

The drive can accept and perform another command which will or will not terminate the current audio play operation as described in the underlined section under the AUDIO PAUSE command description.

PLAY-MODE (Byte 01, bits 3 to 0) specifies the play mode as follows:

(i)	PLAY-MODE = 0000B:	Play with MUTING on.
(ii)	PLAY-MODE = 0001B:	Play R-channel only thru R-channel only.
(iii)	PLAY-MODE = 0010B:	Play L-channel thru R-channel only.
(iv)	PLAY-MODE = 0011B:	Play L/R channels thru R-channel only.
(v)	PLAY-MODE = 0100B:	Play R-Channel thru L-channel only.
(vi)	PLAY-MODE = 0101B:	Play R-chan thru L, R-chan to R-chan.
(vii)	PLAY-MODE = 0110B:	Play R thru L, L thru R.
(viii)	PLAY-MODE = 0111B:	Play R thru L, L/R thru R.
(ix)	PLAY-MODE = 1000B:	Play L channel thru L-channel only.
(x)	PLAY-MODE = 1001B:	Play L-channel thru L, R thru R, STEREO.
(xi)	PLAY-MODE = 1010B:	Play L-chan thru L, L-chan to R-chan.
(xii)	PLAY-MODE = 1011B:	Play L thru L, L/R thru R-channel.
(xiii)	PLAY-MODE = 1100B:	Play L/R thru L-channel.
(xiv)	PLAY-MODE = 1101B:	Play L/R thru L, R thru R-channel.
(xv)	PLAY-MODE = 1110B:	Play L/R thru L-channel, L thru R-channel.
(xvi)	PLAY-MODE = 1111B:	Play L/R thru L-channel, L/R thru R-channel.

The mnemonic for understanding the PLAY-MODE bits is: the right two bits (bits 1 and 0) stand for the speaker right channel output from left and right channels input; the left two bit (bits 3 and 2) stand for the speaker left channel output from left and right channels input.

The TYPE field specifies the format of the Playback Address used in the command. The TYPE field is defined below.

TYPE FIELD	Description
00 B	Specifies Playback address in logical block address format.
01 B	Specifies Playback address in AMIN, ASEC and AFRAME format.
10 B	Specifies Playback address in track number (TNO) format.
11 B	Reserved.

Table 2.5.3.6-2 Playback Address in Logical Block Address format

Bit Byte	7	6	5	4	3	2	1	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							

The logical block address specifies the logical block address at which the play operation will begin or end depending on the setting of the StopAddr bit.

Table 2.5.3.6-3 Playback Address in AMIN, ASEC and AFRAME format

Bit Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-absolute time (AMIN)							
4	CD-absolute time (ASEC)							
5	CD-absolute time (AFRAME)							

The AMIN, ASEC and AFRAME fields specifies the relative running time from the beginning of the disc. The AMIN field has a range of 00 to 99 in BCD. The ASEC ranges from 00 to 59 in BCD. The AFRAME field has a range of 00 to 74 in BCD.

Table 2.5.3.6 Playback Address in Track Number(TNO) format

Bit Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number (TNO)							

The Track Number field specifies the track in BCD notation at which the play operation will begin at the beginning of the specified track or end at the end of the specified track. This field has a range of 01 to 99 in BCD. –

2.5.3.7 AUDIO PAUSE Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: CA$_H$

Table 2.5.3.7-1
AUDIO PAUSE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Pause	Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved		Reserved				Flag	Link

The AUDIO PAUSE command (Table 2.5.3.7-1) temporarily stops audio play operation and enter the hold track state(i.e. keeps the disc at the same Q SUBCODE address).

A Pause bit of one has the effect of temporarily stops audio play operation with MUTING ON and continuing a search of the same SUBCODE Q ADDRESS. The command is valid for use only when the audio play is in progress after the AUDIO TRACK SEARCH or AUDIO PLAY commands. A Pause bit of zero release the audio pause operation and resume the audio play operation at the same Q subcode address just before the start of the audio pause operation.

The audio pause(Pause bit = 1), audio play or audio scan operation can be terminated by a REZERO UNIT, READ, SEEK, START/STOP UNIT, SEND DIAGNOSTICS, PREVENT/ALLOW MEDIA REMOVAL, READ EXTENDED, SEEK EXTENDED, VERIFY, EJECT DISC, READ HEADER, AUDIO PLAY(StopAddr =0), AUDIO PAUSE, AUDIO SCAN, or AUDIO TRACK SEARCH command. The drive will terminated the current audio pause, audio play or audio scan operation and then perform the above command.

The drive should accept and perform TEST UNIT READY, REQUEST SENSE, INQUIRY, RESERVE, RELEASE, MODE SELECT, MODE SENSE, RECEIVE DIAGNOSTIC RESULTS, READ CAPACITY, WRITE BUFFER, READ BUFFER, READ TOC, READ Q SUBCODE, AUDIO STATUS, AUDIO PLAY(StopAddr=1) or AUDIO STOP command without terminating the current audio pause, audio play or audio scan operation in progress.

2.5.3.8 AUDIO STOP Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: CB_H

Table 2.5.3.8-1
AUDIO STOP Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved	Reserved			
2	Stop address (MSB)							
3	Stop address							
4	Stop address							
5	Stop address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	TYPE		Reserved				Flag	Link

The AUDIO STOP command (Table 2.5.3.8-1) specifies the stop address at which the audio play operation will stop. The drive will spin down and the optical pickup is held around the area of the stop address.

If the stop address is zero and the TYPE field is 00B, the AUDIO STOP command will perform the same function as the REZERO UNIT command.

The TYPE field specifies the format of the Stop Address used in the command. The TYPE field is defined below.

TYPE FIELD	Description
00 B	Specifies Stop address in logical block address format.
01 B	Specifies Stop address in AMIN, ASEC and AFRAME format.
10 B	Specifies Stop address in track number (TNO) format.
11 B	Reserved.

Table 2.5.3.8-2 Stop Address in Logical Block Address format

Bit Byte	7	6	5	4	3	2	1	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							

The logical block address specifies the logical block address at which the play operation will stop.

Table 2.5.3.8-3 Stop Address in AMIN, ASEC and AFRAME format

Bit Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-absolute time (AMIN)							
4	CD-absolute time (ASEC)							
5	CD-absolute time (AFRAME)							

The AMIN, ASEC and AFRAME fields specifies the relative running time from the beginning of the disc. The AMIN field has a range of 00 to 99 in BCD. The ASEC ranges from 00 to 59 in BCD. The AFRAME field has a range of 00 to 74 in BCD.

Table 2.5.3.8-4 Stop Address in Track Number(TNO) format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number (TNO)							

The Track Number field specifies the track in BCD notation at which the play operation will stop. This field has a range of 01 to 99 in BCD.

2.5.3.9 AUDIO STATUS Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: CC_H

Table 2.5.3.9-1
AUDIO STATUS Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Allocation Length							
9	Reserved		Reserved				Flag	Link

This command (Table 2.5.3.9-1) transfers the current audio play status and the starting Q SUBCODE address of next track.

The allocation length specifies the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The target terminates the DATA IN phase when allocation length bytes have been transferred or when all available data has been transferred to the initiator, whichever is less.

When the CD-Rom is not in READY state, a check condition is returned.

Table 2.5.3.9-2 Audio Status Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Status Field							
1	Reserved			Play Mode				
2	Reserved				Control Field of current track			
3	Current Q-Subcode (AMIN)							
4	Current Q-Subcode (ASEC)							
5	Current Q-Subcode (AFRAME)							

The Status field is defined as follows:

Status Field	Description
00H	Audio play operation in progress following execution of AUDIO TRACK SEARCH command (Play bit = 1) or AUDIO PLAY command.
01H	PAUSE (i.e. hold track state) operation in progress.
02H	MUTING-ON operation in progress after execution of AUDO TRACK SEARCH command or AUDIO PLAY command.
03H	Audio play completion status.
04H	Error occurred during audio play. operation.
05H	Audio play operation not requested.

The Control Field of the next track is defined as follows.

BIT				Content
3	2	1	0	
0	0	X	0	2 Audio Channels WITHOUT Pre-Emphasis
0	0	X	1	2 Audio Channels WITH Pre-Emphasis
1	0	X	0	4 Audio Channels WITHOUT Pre-Emphasis
1	0	X	1	4 Audio Channels WITH Pre-Emphasis
0	1	X	0	Data Track
0	1	X	1	Reserved
1	1	X	X	Reserved
X	X	0	X	Digital Copy Prohibited
X	X	1	X	Digital Copy Permitted

PLAY-MODE (Byte 01, bits 3 to 0) specifies the play mode status as follows:

(i)	PLAY-MODE = 0000B:	Play with MUTING on.
(ii)	PLAY-MODE = 0001B:	Play R-channel only thru R-channel only.
(iii)	PLAY-MODE = 0010B:	Play L-channel thru R-channel only.
(iv)	PLAY-MODE = 0011B:	Play L/R channels thru R-channel only.
(v)	PLAY-MODE = 0100B:	Play R-Channel thru L-channel only.
(vi)	PLAY-MODE = 0101B:	Play R-chan thru L, R-chan to R-chan.
(vii)	PLAY-MODE = 0110B:	Play R thru L, L thru R.
(viii)	PLAY-MODE = 0111B:	Play R thru L, L/R thru R.
(ix)	PLAY-MODE = 1000B:	Play L channel thru L-channel only.
(x)	PLAY-MODE = 1001B:	Play L-channel thru L, R thru R, STEREO.
(xi)	PLAY-MODE = 1010B:	Play L-chan thru L, L-chan to R-chan.
(xii)	PLAY-MODE = 1011B:	Play L thru L, L/R thru R-channel.
(xiii)	PLAY-MODE = 1100B:	Play L/R thru L-channel.
(xiv)	PLAY-MODE = 1101B:	Play L/R thru L, R thru R-channel.
(xv)	PLAY-MODE = 1110B:	Play L/R thru L-channel, L thru R-channel.
(xvi)	PLAY-MODE = 1111B:	Play L/R thru L-channel, L/R thru R-channel.

The mnemonic for understanding the PLAY-MODE bits is: the right two bits (bits 1 and 0) stand for the speaker right channel output from left and right channels input; the left two bit (bits 3 and 2) stand for the speaker left channel output from left and right channels input.

2.5.3.10 AUDIO SCAN Command

Peripheral Device Type: CD-Rom
Operation Code Type: Mandatory
Operation Code: CD_H

Table 2.5.3.10-1
AUDIO SCAN Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Direct	Reserved			
2	SCAN Starting Address (MSB)							
3	SCAN Starting Address							
4	SCAN Starting Address							
5	SCAN Starting Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	Type		Reserved				Flag	Link

The AUDIO SCAN command requests a fast-forward or fast-reverse scan operation starting from the Scan Starting Address.

The drive can accept and perform another command which will or will not terminate the current audio scan operation as described in the underlined section under the AUDIO PAUSE command description.

A direction (DIRECT) bit of zero indicates a fast-forward operation. A DIRECT bit of one indicates a fast-reversed operation.

SCAN Starting Address - Specifies the address to begin the Audio Fast scan at. The manner of address definition varies with the TYPE field.

The TYPE field specifies the format of the Scan Starting Address used in the command. The TYPE field is defined below.

TYPE FIELD-	Description
00 B	Specifies Scan Starting address in logical block address format.
01 B	Specifies Scan Starting address in AMIN, ASEC and AFRAME format.
10 B	Specifies Scan Starting address in track number (TNO) format.
11 B	Reserved.

Table 2.5.3.10-2 Scan Starting Address in Logical Block Address format

Bit / Byte	7	6	5	4	3	2	1	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							

The logical block address specifies the logical block address at which the Scan operation will begin.

Table 2.3.5.10-3 Scan Starting Address in AMIN, ASEC and AFRAME format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-absolute time (AMIN)							
4	CD-absolute time (ASEC)							
5	CD-absolute time (AFRAME)							

The AMIN, ASEC and AFRAME fields specifies the relative running time from the beginning of the disc. The AMIN field has a range of 00 to 99 in BCD. The ASEC ranges from 00 to 59 in BCD. The AFRAME field has a range of 00 to 74 in BCD.

Table 2.5.3.10-4 Scan Starting Address in Track Number(TNO) format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number (TNO)							

The Track Number field specifies the track in BCD notation at which the scan operation will begin. This field has a range of 01 to 99 in BCD.

------------------------------ END OF SPECIFICATION ------------------------------